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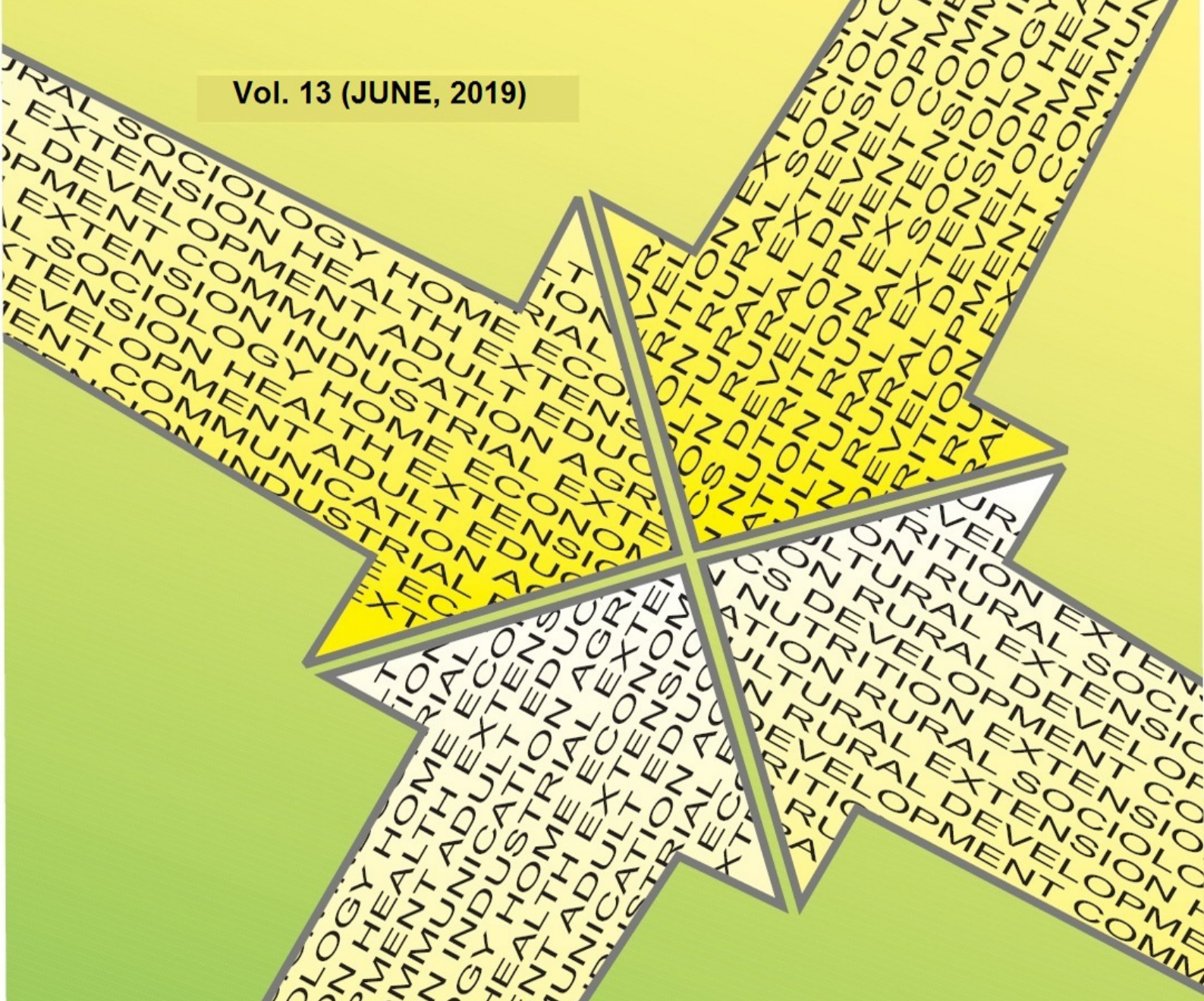

The Nigerian Journal of Rural Extension and Development

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THE NIGERIAN JOURNAL OF RURAL EXTENSION AND DEVELOPMENT (NJRED)

Aims and Scope

The Nigerian Journal of Rural Extension and Development (NJRED), a referred journal, is an annual publication of the Department of Agricultural Extension and Rural Development, University of Ibadan, Nigeria. The journal is intended to encourage systematic and continuous publication of practical ideas and empirical research work in the area of Rural Extension and Development as it relates to Rural Development, Women in Development. Agriculture and Extension Education, Rural Sociology, Livelihood, Mass and Extension Communication, Health and Nutrition Extension, Home Economics, Adult Education and Multi-disciplinary Rural Extension issues.

In addition, the Journal publishes book reviews and research and research –in-brief articles.

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NJRED employs a two-tier review system.

First, the editor reviews each submission to determine its suitability for further peer review by the NJRED Manuscript Review Committee. If the submission is judged as unsuitable, the editor either rejects the submission or highlights weaknesses and proffers revision suggestions to the author(s).

Second, submission judged suitable for further review is sent to 2 reviewers for in-depth assessment based on a blind review process. The reviewers focus on contribution to knowledge and appropriateness of methodology alongside writing style.

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Articles submitted should be provided with a short abstract of about 250 words at the beginning of the text, reporting concisely the main results and important conclusions. At least 3 keywords are required at the base of the abstract.

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b. Author (s), name (s), indicating correspondence author with e-mail address
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List of references for each work cited should be given at the end of the text, in alphabetical order using the APA style of referencing, that is, surname of author (s), initials, year of publication in parenthesis, title of paper, name of journal (underlined or italicized) or book, volume, and first and last pages of the reference.

Tables and figures must be numbered, self explanatory and appropriately referred to in the body of paper. All measurements must be in metric system with currency conversions stated.

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Management practices of aquaculture in Osun state: Implications for sustainable development

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ABSTRACT

This study identified some prevalent management practices of aquaculture in Osun State with a view to investigating if these practices are deemed environmentally responsible and if they are in accordance with sustainable fish farming practices, towards supporting food security in the study area and Nigeria as a whole. Data for the study was collected via the use of questionnaire and a total of 130 respondents were sampled. Management aspects investigated in this study included, sources of fingerling, species cultivated, stocking density, feeding habits, use of genetically modified resources, effluent discharge, social sustainability, marketing channel and economic profitability. Results reveal that most of the management practices investigated were, to a large extent, sustainable except for the management of untreated effluent discharge. It was recommended that government should develop and promote strategic plans that will ensure environmental protection from effluents discharge of aquaculture through the establishment of regulatory bodies to audit aquaculture practices.

Keywords: Sustainable Aquaculture, Fish-farm Management, Responsible fish-farming

INTRODUCTION

Consumption of fish protein by Nigerians constituted about 3.2 million tonnes in the year 2006 (National Bureau of Statistics, 2014). The Federal Government of Nigeria indicated that Nigeria spends about N125.38 billion on annual importation of fish (Food Business International, 2014). This huge spending on importation of fish can be reduced and used to invest in fish farming, thereby boosting domestic production, which invariably creates employment and reduces poverty. However, fish farming or production has to be practiced in a sustainable manner for the industry to remain vibrant.

The concept of sustainable development has since the 1992 Rio Conference on Environment and development been made imperative with the regulatory guide provided by the "The Brundtland report of the World Commission on Environment and development, which defines it as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs". Therefore, it became paramount for every country to interpret the concept of sustainable development in context of its specific development needs. These interpretations are to be taken further for each sector of activity including fishery and aquaculture development. This is to ensure that developmental activities take place at an acceptable environmental cost.

In the agricultural sector of the Nigeria's economy which employs about 70% of the active labour force, fish occupies a unique position in that it is the cheapest source of animal protein consumed by the average Nigerian, accounting for up to 50% of the total animal protein intake (FDF, 2009). With diminishing returns from over fishing in capture fisheries, aquaculture has been growing at some 20% per year since 2003 in Nigeria and continues to attract many investors and new farmers. According to the World Fish Center (2009), aquaculture is the world's fastest growing food production sub-sector, growing at an annual rate of 8.9% since 1970. Land otherwise not suitable for any other form of agriculture can be used for fish farming (aquaculture) such as FADAMA irrigated areas, swamps, spent land, borrow pits, etc. (USAID, 2010).

An example of international work that has been done in reinterpreting sustainable development in relation to aquaculture activities is the Food and Agriculture Organisation's Code of Conduct for responsible fisheries (FAO Code, 1995). The Code seeks to promote adherence to principles and standards favorable to sustainability in the conservation, management and development of fisheries. The 1995 FAO code of conduct for responsible fisheries (article 9), specifically addresses aquaculture development and encourages countries to establish procedures that promote sustainability in aquaculture by the use of strategic planning that are effective and specific to aquaculture so as to undertake appropriate environmental assessment and monitoring aimed at reducing adverse ecological changes and related economic and social impacts resulting from water extraction, land use, discharge of effluents, use of drugs and chemicals and other aquaculture activities.

At the national level, this involves conservation of genetic diversity and integrity of ecosystems by encouragement of appropriate practices and procedures. At the operational level, promotion of responsible aquaculture should involve encouragement and in some aspects, the regulation of chemical inputs that are hazardous to human health and damaging to the state of the environment. Not the least important are the need to prevent aquaculture practices that are actually harmful to the aquaculture industry itself, such as practices that give rise to disease transmission, and the need to ensure food safety in aquaculture products.

The World Bank projected aquaculture to be the prime source of seafood by 2030, as fish demand grows and global wild capture fisheries approach their maximum take. When practised responsibly, fish farming can help provide livelihoods and feed a global population that will reach nine billion by 2050 (World Bank, 2014).

The aquaculture system can truly be sustainable if the following issues are considered;

- Environmental sustainability: effluents discharge or fish loss from aquaculture should not cause a tangible disruption to the ecosystem such as substantial pollution impact or result in loss of biodiversity.

- Economic sustainability: Aquaculture as a business must be viable to encourage committed investors.

- Social and community sustainability: Aquaculture must be socially responsible and contribute to community well-being.

A number of certification programs have made advancement in defining key characteristics of sustainable aquaculture. Such essential practices according to World Bank (2014) include:

- Environment practices: conservation of mangrove and wetland; effective and efficient effluent management and water quality control; control of sediment and sludge management; conservation of soil and water; efficient fishmeal and fish oil use; sourcing of broodstock and juvenile fish responsibly; control of escapes and minimizing biodiversity and wildlife impact.

- Community practices: establish well-defined rights, aquaculture zones and responsibilities for aquaculturists, compliance with established regulation and effective enforcement; community involvement; worker safety, fair labor practices and equitable compensation.

- Sustainable business and farm management practices: effective biosecurity and disease control systems; minimal antibiotic and pharmaceutical use; microbial sanitation; maintain global standards for hygiene; efficient and humane harvest and transport; accountable record-keeping, traceability and profitability of the aquaculture business.

Domestic production of fish in Nigeria is about 511,000 metric tonnes, which can only meet about one third of demand while the country imports more than 700,000 metric tonnes of fish each year at a cost of some US $ 0.7 billion. This is in spite of the fact that the country has the capacity to produce more than 3 million metric tonnes of fish per year with 14 million hectares of inland waters, 853 km^2 of coastline bordering an extensive mangrove ecosystem comprising lagoons, estuaries, wetlands and series of interconnecting creeks and considerable interest in aquaculture from the private sector (FAO, 2005).

Sustainable aquaculture is a dynamic concept and the sustainability of an aquaculture system will vary with species, location, societal norms and the state of knowledge and technology (World Bank, 2014). The growth of aquaculture and its response depends on management strategies, management technique and fish stock management techniques (Payne, 1986).

This paper identified some prevalent management practices of aquaculture in Osun State with a view to investigating if the practices are in accordance with sustainable fish farming practices, towards ensuring food security in the study area and Nigeria as a whole. The aspects investigated include, sources of fingerling, species cultivated, stocking density, feeding habits, use of genetically modified resources, effluent discharge, social sustainability, marketing channel and economic profitability.

Study Area

Osun state was created in 1991 from the eastern third of Oyo state. It is a land-locked state that covers an estimated area of 8,062 square kilometres. It lies within latitudes 6^o and 9^o N of the equator and approximately between longitudes 2^o and 7^o E of Greenwich meridian (Anamayi, *et al*., 2010). The state has a covering of tropical rain forest, and the Osun is the most important river. Osun's economy is based mainly on agriculture. Agriculturally, Osun state is divided into three Zones: Osogbo zone, Iwo zone and Ijesa- Ife zone. Osun state comprises of thirty-one local governments.

Methodology

Three agriculture zones of the state, namely, Iwo zone, Osogbo zone and Ijesa-Ife zone were purposively selected and one hundred and fifty respondents were randomly selected (fifty respondents for each zone) from various local government area within the region based on the intensity of aquaculture practices in the area. However, only 130 responses were analyzable.

Structured questionnaire was used to obtain information from the respondents. The study was socio-economic in nature and farmers were asked questions to reveal their demographic characteristics, prevailing farm management practices such as; sources of fingerling, species cultivated, stocking density, feeding habits, use of genetically modified resources, effluent discharge, and social and economic sustainability.

The data collected were subjected to descriptive statistics such as frequency counts and percentages. Returns on investment (ROI) were used to analyze profitability of fish farming. The formula for ROI is as shown below:

ROI = (Net profit/Cost of investment) x 100.

Socioeconomic characteristics of respondents:

Table 1 indicates the social characteristics of respondents. These include their age, marital status, level of education and source of finance. The results show that majority of fish farmers in Osun state were between the ages of 36 and 50 years (51.5%), mostly married (69.0%) with an average family size of 6. Most of the respondents are educated with 38.0% attaining university education. This could indicate the higher level of skill or technicality involved in fish farming as it is with other types of animal farming such as poultry, Adedeji *et.al.* (2014). Majority of the respondents obtained their initial investment funds from personal savings, which suggests there may be inability or difficulties involved in obtaining financial credits such as loans for starting a venture like fish farming. However, there are prospects that this condition may change for farmers because the Federal Government of Nigeria through the Central Bank of Nigeria (CBN) in collaboration with Federal Ministry of Agriculture and Rural Development (FMARD) has established Commercial Agriculture Credit Scheme (CBN, 2014). However, farmers will need adequate information on how to harness the scheme efficiently through their local financial institutions.

RESULTS AND DISCUSSIONS

Table 1: Distribution of respondents by socioeconomic characteristics

Age	Frequency	Percentages
<35	22	17.0
36-50	67	51.5
>51	41	31.5
Marital Status		
Single	32	25.0
Married	90	69.0
Widowed	3	2.0
Divorced	5	4.0
Educational background of respondents		
Modern school	12	9.0
Secondary school certificate	23	18.0
Koranic school	8	6.0
Polytechnic/National Certificate of Education	38	29.0
University	49	38.0
Source of finance		
Personal savings	89	69.0
Bank loan	14	11.0
Cooperative	23	18.0
Donation and other sources	2	2.0
Total respondents	130	100.0

Sources of fingerlings

Figure 1 indicates that the farmers procured their fingerlings (fish seed) mainly from other fish farm hatchery 79.0% and18.0% acquired fingerling from the wild, 1.0% respondents self-bred, while the source of acquisition for 2% of the respondent could not be identified. The use of wild-caught fingerlings does not support sustainable aquaculture as wild captured fingerlings are seasonal, have limited growth, usually made up of different strains, which may be difficult to separate

by uninformed farmers (Anetekhai, *et al*, 2004). These results indicate support for sustainable development, as most farmers sourced their fish seeds from controlled culture systems (hatcheries). This also indicates the industry is gradually overcoming the bottleneck of sourcing good quality fingerlings. This is because in Anetekhai *et. al.* (2004), reported that there were very few hatcheries in Nigeria and most of them produce below 10% capacity as a result of lack of brood stocks, skilled manpower, good water, electricity, live food for fries, difficulty in obtaining natural hormones and expensive nature of synthetic hormone.

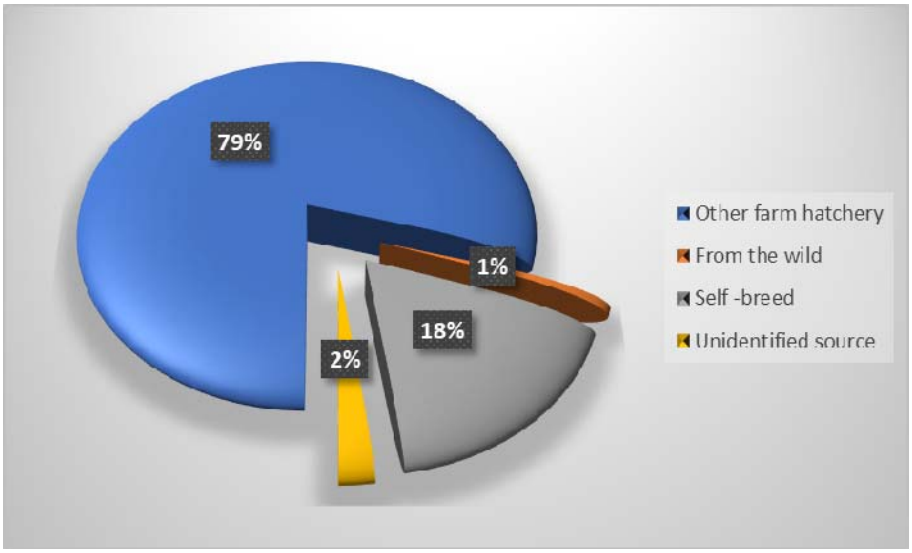

Figure 1: Sources of fingerlings

Species cultivated and culture system

The culturing system adopted by most respondents is monoculture with78.0%, while 22% practised poly culture with tilapia species. Species cultivated in the study area included; catfish species (*Clarias gariepinus, Heterobranchus bidorsalis*) and tilapia species. These species support the principle of sustainable aquaculture, which requires species, cultivated to be native to open water systems. The use of non-native species has been known to become pests that lead to economic losses as they prey on and compete with native species, change or alter aquatic habitat. The 1995 FAO code encourages nations to perform a risk assessment when embarking on the use of non-native species.

Results obtained on culture systems show that 15.0% of respondents practiced extensive management system, 74%, semi –intensive management system, while 11.0% practiced intensive management system. This indicates that most Osun state fish farmers practiced semi-intensive management system of which 60% practiced integrated fish farming, while 40.0% practiced purely fish farming. Among those that practice integrated fish farming, 65% were involved fish cum poultry 12.0% involved in fish cum piggery and 23% involved in fish cum poultry, sheep and goats.

Stocking density

Average stocking density for the study area was recorded at 2,300 fingerlings per ha. However, 78.0% of the respondents indicated that they stocked their pond based on their financial capability.

Stocking density is one of the crucial factors that determine fish growth and final biomass that will be harvested (Engle and Valderrama, 2001; Rahman *et al*., 2005, Boujard *et al*., 2002).

The respondents also had practices such as segregation by size which helps not only to regulate population density, but equalizes competition for food and reduces cannibalism of the smaller fishes by the shooters especially in the culture of catfish. Identifying optimum stocking density for a species is a critical factor not only for designing an efficient culture system (Leatherland and Cho, 1985), but also for optimum husbandry practices (Dasuki *et al*. 2013). Sustainable aquaculture should use stocking densities that support the welfare of fishes by minimizing risk of disease outbreaks and transmission. The stocking practices of aquaculturists in the study area are adequate and promote sustainability.